vessels engaged in such work have had. Each year new improvements have been made. The 'trawl-wings,' first introduced by us in 1881, have been used with great success; for they have brought up numerous free-swimming animals from close to the bottom, which would not otherwise have been taken. The use of steel wire for sounding, and of wire rope for dredging, has enabled us to obtain a much greater number of dredgings and temperature observations than would have been possible under the old system of using rope, employed even on the Challenger. The use of steel-wire rope for dredging, first invented by Mr. A. Agassiz, and very successfully employed by him on the Blake, has proved to be an improvement of very great value in deep water. By its use there is an immense saving of time, and consequently a great increase in the value of the results. As an illustration of the rapidity with which dredging has been done on the Fish Hawk by using the wire rope reeled upon a large drum, I give here memoranda of the time required to make a very successful haul. In 640 fathoms, at station No. 1124, the large trawl was put over at 4.29 P.M.; it was on the bottom at 4.44, with 830 fathoms of rope out; commenced heaving in at 5.17; it was on deck at 5.44 P.M.; total time for the haul, 1 hour and 15 minutes. The net contained several barrels of specimens, including a great number and large variety of fishes, as well as of all classes of invertebrata, — probably more than 150 species altogether, many of them new.

At all the localities that we have examined, the temperature of the water, both at the bottom and surface, was taken, as well as that of the air. In many cases, series of temperatures at various depths were also taken. Many other physical observations have also been made and recorded. Lists of the animals from each haul have been made with care, and arranged in tables, so far as the species have been determined up to date.

South of New England the bottom slopes very gradually from the shore to near the 100-fathom line, which is situated from 80 to 100 miles from the mainland. This broad, shallow belt forms, therefore, a nearly level, submarine plateau, with a gentle slope seaward. Beyond the 100-fathom line the bottom descends rapidly to more than 1,200 fathoms into the great ocean-basin, thus forming a rapidly sloping bank, usually as steep as the slope of large mountains, and about as high as Mount Washington, New Hampshire. This is well shown by diagram 1, which illustrates the relative slope at several lines of dredging, and the *actual* slope $n'-o'$ along the line $n-o$. We call this the Gulf Stream slope, because it underlies the inner portion of the Gulf Stream all along our coast, from Cape Hatteras to Nova Scotia. In our explorations a change of position of less than 10 miles, transverse to the slope, sometimes made a difference of more than 3,500 feet in depth.

[*To be Continued.*]

THE INTERNATIONAL FISHERIES EXHIBITION.

IT is just thirty-two years, nearly the third part of a century, since international exhibitions were inaugurated. The 'Great exhibition' of 1851 marks an epoch in the history of England. It brought with it new aspirations for culture, and new methods of education in science pure and applied, in the arts aesthetic and industrial, arousing them to a new intellectual life. "The Great exhibition of 1851," remarks a popular novelist, a social philosopher as well, "did one great service for country people: it taught them how easy it is to get to London, and what a mine of wealth, especially for after-memory and purposes of conversation, exists in that big place." It gave them the great treasure-houses of South Kensington, and the smaller kindred museums in all parts of the United Kingdom.

The world at large has profited by the same experience, though perhaps to a less degree. Every nation, almost every great city, has had its 'world's fairs,' and, according to its capacity, has profited by their lessons. It is doubtful whether we shall ever see another universal exhibition so extensive as those of Philadelphia (1876), of Vienna (1873), and of Paris (1867). The ideal has become too lofty; and the exhibition of to-day, like the worker, must be devoted to a specialty. The fisheries exhibition, soon to open at South Kensington, is as nearly as possible upon the site of the exhibition of 1851, and covers precisely the same area of ground; namely, twenty-one acres. It would be instructive to estimate how large an extent of territory would be covered by an exhibition in which should be represented, with the minuteness of to-day, all the divisions of the classification of 1851, — a classification, which, for minuteness, comprehensiveness, and philosophical system, has not since been equalled. An entire English shire would hardly suffice.

Special exhibitions have probably entirely superseded those of general scope, and their number is yearly increasing. In one year, re-

cently, the government of Austria participated in fifteen. Amsterdam, Zurich, Lisbon, Hamburg, Vienna, Madras, and Tokio, among others, have exhibitions of varying scope now in progress, or soon to open.

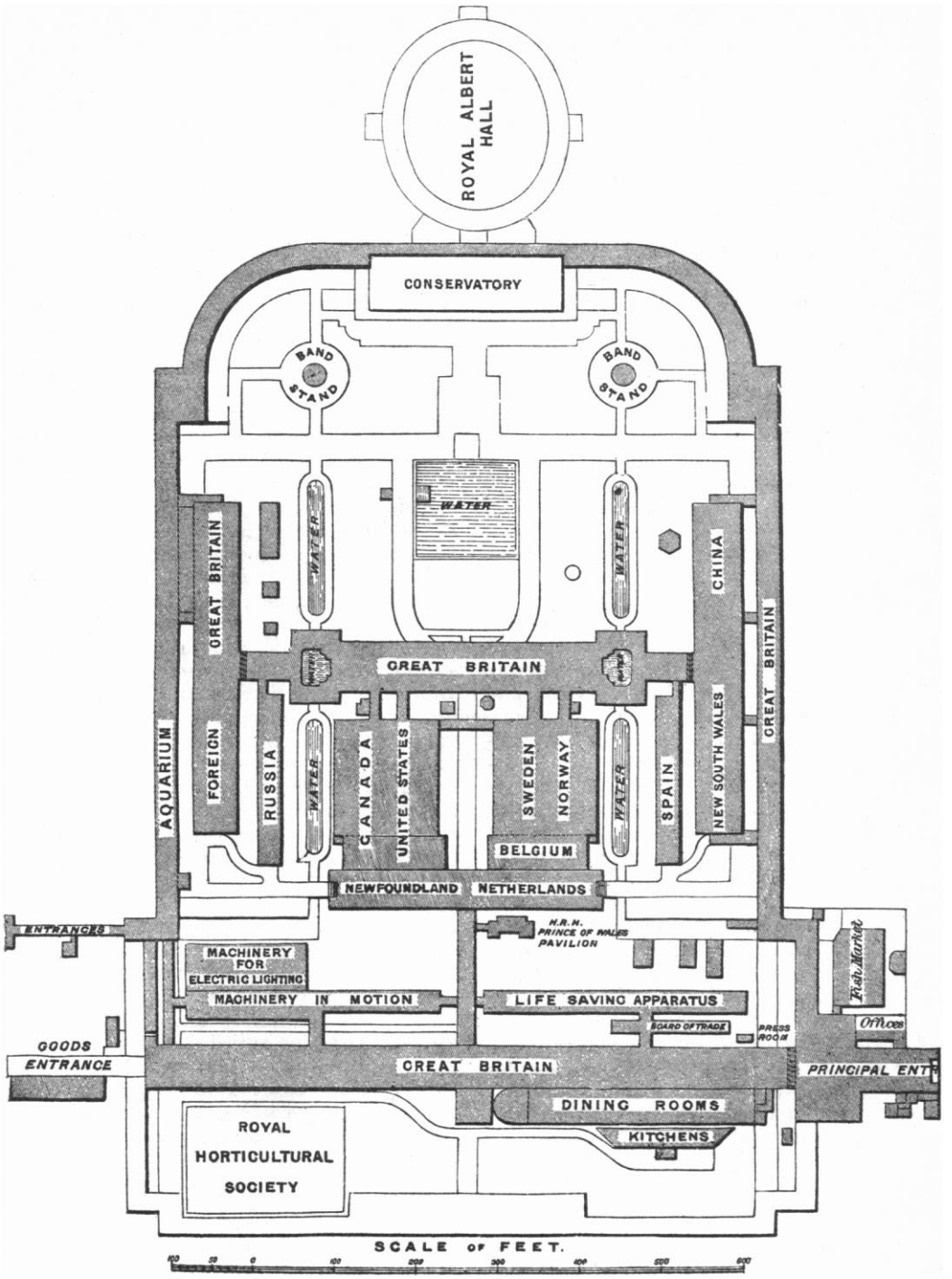
The fisheries exhibition is an institution at the success of which even the most sanguine seem to be astonished. No one has yet propounded a theory which explains satisfactorily the reason why these exhibitions succeed, yet succeed they do, perhaps more fully than special exhibitions of any other kind; and, moreover, they seem to enlist the interest of a larger number of scientific workers than do other exhibitions, though, of course, the electrical, geographical, and meteorological exhibitions are attractive in a higher degree to the students of those individual specialties.

The Berlin fisheries exhibition of 1880 was largely under the control of specialists in science. Among its most active supporters were men like Virchow, Peters, Magnus, Hilgendorf, Dohrn, Möbius, Von Siebold, Nitsche, Oscar Schmidt, H. A. Meyer, Wittmack, and Jäger, almost all of whom were on the board of direction; while, as commissioners and jurors, Italy sent Targioni-Tozzetti, Giglioli, Ricchiardi, Pavesi, Vinciguerra, and Cavanni, in short, all her marine zoölogists; Bohemia, Fritsch; Denmark, Lütken; Russia, De Solsky and Grimm; Norway, Raasch and Collet; and Sweden, Smitt, Thorel, and Malm. It is not difficult to understand why a statesman, diplomatist, and political economist like Professor Virchow should be willing to give up his days and nights for two months to committee and jury meetings, when it is remembered how much stress Germany places upon all which relates to the food-supply and the economy of all natural resources; but other interests must have influenced men like Von Siebold and Peters.

A similar array of names known to science appears in the prospectus of the London exhibition. Among the vice-presidents are the Duke of Argyll, Lord Walsingham, Sir John Lubbock, Professor Huxley, Dr. Gunther, and Mr. Spottiswoode, several of whom, together with Professor Flower, Mr. Robert H. Scott, Sir Philip Cunliffe Owen, and Mr. Saville Kent, are members of the general committee. It seems a little remarkable, however, to see the name of the president of the Royal society standing at the very tail of the list of vice-presidents, followed only by "The prime warden, wardens, and court of assistants, of the fishmongers company." At the other extreme is placed H. R. H. the Duke of Edinburgh. James Russell Lowell, Esq., is also a vice-president, his name standing between those of the Duke of Westminster and the Marquess of Salisbury.

Among the foreign commissioners are Prof. F. A. Smitt of Stockholm, R. Trybom of Lund, and Dr. Malm of Gothenburg, Professor De Solsky of St. Petersburg, Professor Hubrecht and Baron Von Hert of Utrecht, Professor Giglioli of Florence, Professor Nitsche of Tharandt, and Dr. M. Lindeman of Bremen. Surgeon-Gen. Francis Day is acting as commissioner for India.

An examination of the classification of the exhibition discloses the nature of the tie which binds together the varied interests represented in the lists of names which have been quoted. The ethnologist and the mechanician, as well as the fisherman, are concerned in the 'fishing-gear and the fishing-craft of all nations;' the meteorologist and the pharologist, as well as the philanthropist, in the 'life-saving apparatus of all kinds;' the physicist, as well as the navigator, in the "compasses, barometers, telescopes, lights, lamps, fog-horns, systems of signalling, electric lights, luminous paint and other equipments of fishing-vessels," and in "methods of communication from the shore to lightships and fishing-fleets by submarine cables, telephone, or other means of signalling;" while the geographer and geologist find something to interest them in the charts and relief-models of the ocean and its bottom. The chemist, the sanitarian and physiologist, as well as the merchant, transporter, and manufacturer, are touched by the section which illustrates the preparation, preservation, and utilization of fish, and the food, apparel, and dwellings of the fishermen. The jurist, the statesman, and the historian may study the "History and literature of fishing, fishery-laws, and fish-commerce." Biologists of every class must study classes IV. and V.; for the word 'fish' is broadly interpreted, and is held to signify any creature living in the waters: to wit, as enumerated, *a*, Algae, to be arranged under genera and species, with localities appended; *b*, sponges in their natural state; *c*, corals in their natural state, polyps, jelly-fish, etc.; *d*, entozoa and epizoa; *e*, mollusca of all kinds; *f*, star-fishes, sea-urchins, holothurians; *g*, worms used for bait, or noxious; leeches, etc.; *h*, perfect insects, and larvae of insects, which are destroyers of spawn, or serve as food for fish; *i*, crustacea of all kinds; *k*, fish of all kinds; *l*, reptiles, such as tortoises, turtles, terrapins, lizards, serpents, frogs, newts, etc.; *m*, aquatic and other birds hostile to fish or fishing; *n*,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NORWAY
SPAIN
NEW SOUTH WALES
BELGIUM
NEWFOUNDLAND
NETHERLANDS
ENTRANCES
H.R.H. PRINCE OF WALES PAVILION
MACHINERY FOR ELECTRIC LIGHTING
MACHINERY IN MOTION
LIFE SAVING APPARATUS
BOARD OF TRADE
PRESS ROOM
Offices
Fish Market
GOODS ENTRANCE
GREAT BRITAIN
PRINCIPAL ENTR
DINING ROOMS
KITCHENS
ROYAL HORTICULTURAL SOCIETY
SCALE OF FEET.

aquatic and amphibious mammalia (otters, seals, whales, etc.), and others detrimental to fish. As if this were not sufficiently catholic, division 40 is a trap to catch any interests not already retained. It is defined as follows, under the head 'scientific investigation:' physico-chemical investigation into those qualities of salt and fresh water which affect aquatic animals; investigation of the bottom of the sea and of lakes, shown by samples; aquatic plants in relation to fishing, etc.; researches into the aquatic fauna (animals of the several classes preserved in alcohol, or prepared, etc.); apparatus and implements used in such researches.

Ten of the twenty-three subjects announced for the essays are purely biological, and many of the others can be handled only by scientific investigators.

The fisheries exhibitions of to-day are therefore more than their names would seem to indicate. Perhaps they might more appropriately be called hydrological exhibitions. Their scope has increased as they have become more popular. The first, held at Amsterdam in 1861, was much less ambitious. Others followed at Bergen, Norway (1865), Arcachon, France (1866), Bologne (1866), The Hague (1867), Aarhuus, Denmark (1867), Vienna (1867), Gothenburg, Sweden (1867), Havre (1868), Naples (1871), Berlin, London (1878); and in Berlin, in 1880, the climax was apparently reached in a display, which, for extent and completeness, no one supposed would ever be surpassed. Great Britain has since had exhibitions at Edinburgh, Norwich, and Tynemouth; and attention of the whole nation is now concentrated upon the exhibition which is to be opened by the Queen on the 12th. It is generally admitted that it is the most important exhibition held here since the Great exhibition of 1851. Twenty-five nations and colonies are represented. In the catalogues and in the announcements the place of honor is given to the United States; and the officers do not hesitate to admit that the success of the affair was largely assured by the prompt and liberal action of our government, — action which may be regarded as, in part, an acknowledgment of the very generous manner in which England participated in our own exhibition in Philadelphia in 1876.

South Kensington, May 1. G. Brown Goode.

THE WEDGE-PHOTOMETER.

This instrument has been attracting considerable attention during the last year, and has been especially studied by Professor Pritchard of Oxford and Professor Pickering of Harvard, to each of whom we owe a form of the instrument. It depends for its efficiency on the accurate observation of the time of extinction of the light of a star; and as it is evident that the various sources of error in photometric work — moonlight, the state of the atmosphere, the condition of the eyes of the observer, the position of observation, whether that of comfort or constraint — would affect a faint point of light near extinguishment more than they would the brighter lights used in other photometric methods, any contribution to the question of the accuracy to be expected from the wedge-photometer may be of interest.

The instrument employed by me is of the form suggested by Professor Pickering. It was made by Mr. J. Grunow of New York, and seems to be very good work. It consists of a wedge of London smoke glass an inch square, and about a twentieth of an inch thick at its blunt edge, a large low-power positive eye-piece, and a special adapter, and is a very convenient photometer to use. The color of the wedge is deep enough to give one magnitude of the ordinary scale of the brighter stars for each five seconds in the time of extinction at the equator.

For the study of the accuracy of observation with this instrument, I selected the Durchmusterung star 22°.2164, of which Argelander puts the magnitude at 5.3. In observation I took alternate observations on this, and the star to be compared with it, until I had five for each star, which I called a set of observations. By this method I made the conditions of observation as nearly as possible the same for the two stars, and thus the difference in their time of extinction nearly free from error.

My comparisons were made chiefly with the star Durchmusterung 22°.2163 of the catalogued magnitude 8.8. Between April 2 and April 29 I made twenty-eight sets of observations on the two stars. The difference in their time of extinction varied from 19.1 seconds to 21.6 seconds; approximating, however, pretty closely to the mean 20.6 seconds, of which the probable error was ± 0.09 in seconds, equivalent to ± 0.015 in magnitudes. The mean error of a single set of observations is ± 0.68 seconds, or ± 0.12 magnitudes. A series of four sets of comparisons of star 21°.2156 gave a mean error of ± 0.68, and a probable error of ± 0.23; and a series of five sets with 21°.2156 gave ± 0.83 and ± 0.24, in both cases in seconds.